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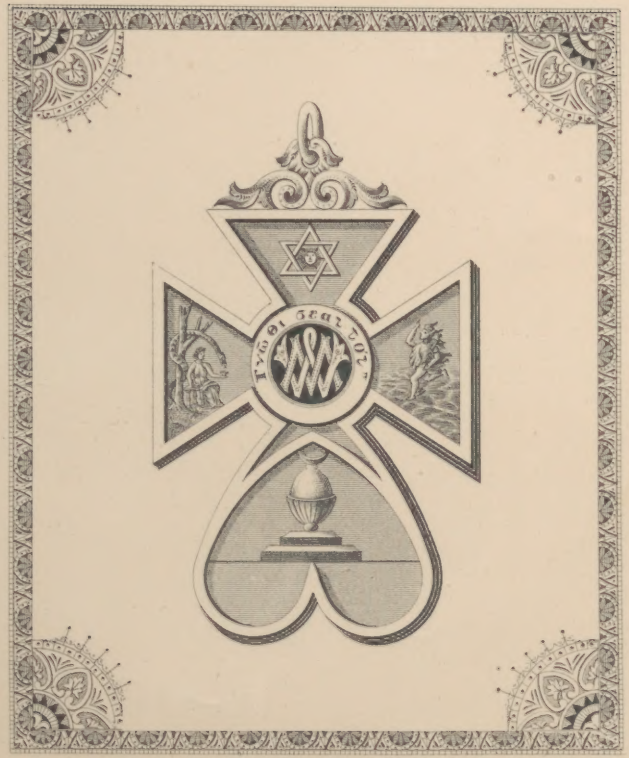

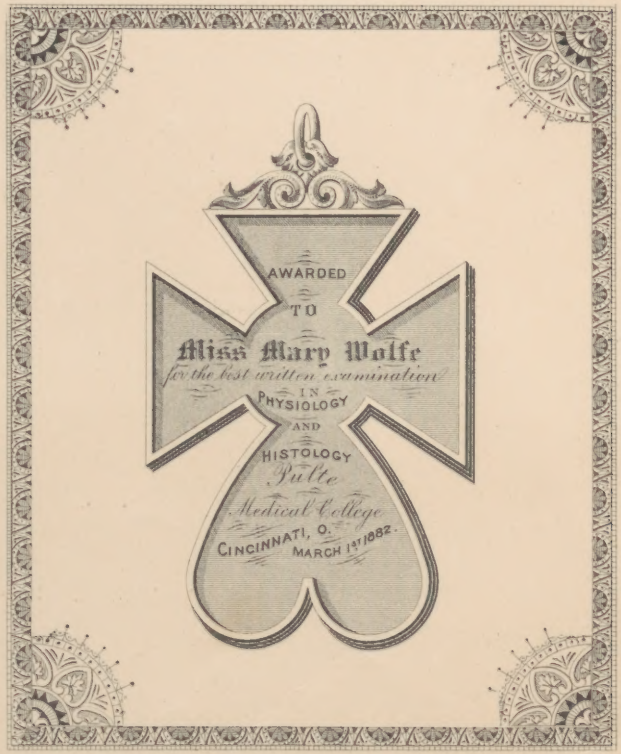
AWARDED
TO
Miss Mary Wolfe
for the best written examination
IN
PHYSIOLOGY
AND
HISTOLOGY
Pulte
Medical College
CINCINNATI, O.
MARCH 1st 1882.

PRIZE PAPER

ON

PHYSIOLOGY AND HISTOLOGY,

BY

MARY WOLFE,

CLASS OF 1883,

PULTE MEDICAL COLLEGE,

CINCINNATI,

1882.

146 SMITH STREET, CINCINNATI, O.,
March 10, 1882.

Professor J. M. CRAWFORD,

DEAR SIR:

The complimentary terms in which you spoke of MARY WOLFE'S written examination in Physiology and Histology in your public speech, at the Commencement Exercises of Pulte Medical College, at College Hall in the Mercantile Library Building in this city, March 1st, 1882, and to memorialize which was awarded an elegant gold medal, have caused many personal friends to express a desire to read it.

Will you be kind enough to allow me a *verbatim* copy of her paper?

Yours truly,

N. B. WOLFE.

COR. SEVENTH AND MOUND, CINCINNATI, O.,
March 11, 1882.

DR. N. B. WOLFE,

DEAR SIR:

Your note of yesterday is before me, asking for a *verbatim copy* of your daughter's examination paper, and I cheerfully comply with your request.

The committee that awarded the medal to Miss MARY WOLFE did so with entire unanimity. Her paper was *best* in that comprehensive sense which includes general scholarship, as well as physiological knowledge. The reading of it, I trust, will show to yourself and friends, as it did to the members of the committee, that the medal was worthily bestowed.

I am sincerely yours,

J. M. CRAWFORD.

INTRODUCTION.

It will be a matter of interest to our friends to learn the circumstances under which the following paper on Physiology and Histology was written, and how the award of the gold medal was made.

Professor J. M. Crawford announced to the members of his class that he desired them to assemble in the amphitheater of the college, on Wednesday, at ten o'clock, A. M., of examination week. When they came together, he handed to each student a paper containing the following examination questions:

I. *Name the Contents of the Respective Regions of the Anterior Portions of the Chest, and give the Signs of Normal Functions of the Organs in each Region.*

II. *Give the Divisions of Proximate Principles of the Blood, and the Important Peculiarities of each.*

III. *Describe fully the Process of Mastication, and give the Mechanism of Deglutition.*

IV. *Describe Saliva, Gastric Juice, Pancreatic Juice, and give the Mechanism of their Secretion and the Function of each.*

V. *In the Digestive Process, give the Successive Steps by which the Food finally enters the Blood.*

VI. *Give the Relations of the Nervous System to the Glycogenic Function of the Liver.*

VII. *Give the Physiological Anatomy of the Kidney, and Mechanism of the Secretion and Excretion of Urine.*

VIII. *Give the Mechanism of Respiration, and the Means by which Oxygen is conveyed to the Tissues.*

IX. *Give the Mechanism of the Continuous Flow of Blood in the Veins, and the Cause of a Systemic Venous Pulse.*

X. *Describe fully a Nerve, and give its Physiological Properties.*

The Professor supplemented these questions by stating that during the examination the students were expected not to converse with each other, nor to ask questions or refer to memoranda. In short, the class was given to understand that every student was expected to do *square work*. As each paper was finished it was delivered to Professor Crawford, who was present during the entire examination.

At the commencement exercises of Pulte Medical College, in College Hall of the Mercantile Library Building, March 1, 1882, after the addresses and valedictory had been delivered, the Dean of the college, Professor J. D. Buck, announced that "the next thing on the printed programme is the delivery of the diplomas to the graduating class; but, before doing this, one of the exercises of the evening, not set down, as it should have been, will now take place." Hereupon Professor J. M. Crawford came to the front of the rostrum, and said substantially:

"A friend to education and to Pulte Medical College, who does not wish his name made public, but who entertains a high appreciation of the study of Physiology and Histology, as constituting the foundation of a reliable medical education, in order to encourage application and reward success, placed in my hands, early in the term, funds to provide an annual prize, to be presented to the student who gives the *best examination paper* in this department of medical study. This award will be called 'THE UNKNOWN PRIZE,' and, like the Protean body, will take any shape

that may seem at the time best calculated to reward the victorious competitor. This year it takes the form of a gold medal. Whence it comes you will never know; but whither it goes, each succeeding commencement, during my connection with the college, will reveal.

"The duty of selecting the one entitled to receive this award has been scrupulously performed by the Professor of Physiology, assisted by the Dean and other members of the Faculty. Among the papers of merit which they have examined and indorsed as worthy of honorable mention, there was one that attracted special attention, and commanded the admiration of the examining committee. This paper was found not only to be unusually comprehensive and exact in its grasp and arrangement of physiological and histological facts, but its statements were clear, concise, and in classic English.

"The prize I hold in my hand. You perceive it has the shape of a Greek cross, the base modified to resemble the human heart. On the face of the top section of the cross is engraved the symbol of the astral lights, a dual triangle forming a star, in the center of which is the radiant face of the sun. On the right section appears Mercury, with winged feet, walking upon a troubled sea, himself resplendent in the ambient air, bringing his appropriate message. On the left is ornately engraved a representation of Hygeia, the daughter of Esculapius, in the attitude of receiving light for her lamp from the emblem of wisdom, the serpent. The lower part of the cross is heart-shaped, on which is engraved the mundane egg, the mother source of natural life. Thus are symbolized in this beautiful jewel, the four elements, Fire, Water, Air, and Earth, associated with Wisdom, all contributing to Health. The circle in the center of the cross contains a beautiful enameled monogram, surrounded, in engraved Greek char-

acters, with the well-known motto, *Γνωθί Σεαυτόν*, 'Know Thyself.' On the reverse of this medal is inscribed this personal legend:

AWARDED

TO

Miss Mary Wolfe,

FOR THE

Best Written Examination

IN

PHYSIOLOGY AND HISTOLOGY,

Pulte Medical College,

Cincinnati, March 1st, 1882.

"My duty is now done. Miss Wolfe, receive your medal. I trust the success which this symbolizes will stimulate you to still greater efforts in the pursuit of knowledge."

Physiology and Histology.

I.

Name the Contents of the Respective Regions in the Anterior Portion of the Chest, and give the Signs of Normal Function in each Region.

A. Supra-clavicular Region.

Contents. On both sides it contains the apices of the lungs, the common carotid arteries and jugular veins, and the subclavian arteries and veins.

Signs of Normal Function. On palpation is found the pulsation of the carotid arteries; on percussion, pulmonary resonance; on auscultation, pure vesicular murmur, and scarcely audible voice.

B. Clavicular Region.

Contents. On both sides is found vesicular lung structure. On the right side are the innominate and subclavian arteries and their accompanying veins. On the left side are the common carotid and subclavian arteries, with their veins.

Signs of Normal Function. On palpation, the clavicle is felt; on percussion, dullness, and high-pitched resonance result; on auscultation, pure vesicular murmur, and scarcely audible voice are heard, except at the sternal end, where are found bronchial breathing and bronchophony.

C. Infra-clavicular Region.

Contents. On both sides are found the vesicular structure of the lungs, and the main branches of the bronchial tubes. On the right side, the vena cava and aorta are found, the right bronchus, the bronchial artery and vein. On the left side is a portion of the pulmonary artery, the bronchial artery, the left bronchus, and the vein.

Signs of Normal Function. On palpation, vocal fremitus is felt, more on the right side; on percussion, pulmonary resonance results; on auscultation, scarcely audible voice, and pure vesicular murmur, mixed with bronchial breathing, blended throughout the whole region, are heard, the vesicular murmur being more distinct toward the axillary region, the bronchial breathing toward the sternal; the heart sounds are found on the left side, at the lower border of this region.

D. Mammary Region.

Contents. On both sides are lung structure and bronchial bifurcations. On the right side the heart's border is found behind the lung; also, on deep inspiration, the liver, when it rises to a level with the fifth rib. On the left side the lung is moved aside for the heart; beginning at the fourth sterno-costal articulation, extending down to the fifth intercostal space, and returning again at the sixth.

Signs of Normal Function. On palpation, there is slight vocal fremitus; on percussion, there is resonance on both sides, except on the left, over the region of the heart, where there is dullness and higher pitch; on auscultation, there is feeble vesicular murmur on the right side below, on both sides above; on the left side, at the junction of the third rib with the sternum, is heard the second sound of the heart; at the junction of the fourth rib with the sternum is heard the first sound of the heart. These are the points of

greatest intensity; the sounds are propagated into the surrounding area, and diffused throughout the chest. The voice is hardly audible.

E. Infra-mammary Region.

Contents. On the right side is found the liver; in the superior portion of the region the lung is in front of it. On the left side are the anterior portion of the base of the lung, a small part of the left lobe of the liver, the anterior border of the spleen and the cardiac end of the stomach.

Signs of Normal Function. On palpation, resistance from the presence of the liver, and the apex beat of the heart are found; on percussion, dullness and high pitch over the region of the liver and spleen, and tympanitic resonance over the stomach, result; on auscultation, vesicular murmur is heard on both sides.

F. Supra-sternal Region.

Contents. The trachea, and sometimes the tip of the transverse portion of the arch of the aorta, are found; also the arteria innominata at its lower border.

Signs of Normal Function. Palpation and percussion are of little value here; on auscultation, tracheal breathing is heard.

G. Superior or Upper Sternal Region.

Contents. The division of the trachea, the aorta, and great vessels are found here. The heart lies partly in this region. The pulmonary valves are on a level with the third rib, the aortic valves below.

Signs of Normal Function. Palpation reveals the presence of the sternum; on percussion there is clear resonance of high pitch; on auscultation, bronchial breathing, bronchophony, and reflected heart-sounds are heard.

H. Inferior or Lower Sternal Region.

Contents. The anterior mediastinum above, the stomach below, a part of the heart and a small portion of the lung on its right border are found; also the attachment of the pericardium to the diaphragm. The mitral valves are situated near the left side at the sterno-costal articulation of the fourth rib; the tricuspid valves are nearer the median line, below the aortic valves.

Signs of Normal Function. On percussion, resonance is clear in the upper part of the region, and tympanitic in the lower part; on auscultation, the heart-sounds are heard. The first sound is synchronous with the closing of the auriculo-ventricular openings; the second, with that of the pulmonary and aortic. The normal heart-beat may be divided into four periods: the first sound occupying four-tenths of the time; the first rest, one-tenth; the second sound, three-tenths; the second rest, two-tenths. Pure vesicular murmur is heard above, and but feebly below. The voice is hardly audible in this region.

II.

Give the Divisions of the Proximate Principles of the Blood and the Important Peculiarities of Each.

THE proximate principles of the blood are found in the plasma. They may be divided into five classes, as below:

A. ORGANIC NITROGENIZED.

These are intimately connected with the vital principles, and enter directly into the nourishment of the tissues. They are all in a state of continual change in the body, constantly wearing out and becoming effete, when they take the form of excrementitious substances. This class of proximate principles is of organic origin exclusively; they are not crystallizable, and are of indefinite chemical composition. Plasma is largely made up of them; fibrin, plasmin, paraglobulin, metalbumin, and fibrinogin are examples.

B. ORGANIC NON-NITROGENIZED.

These principles are essential to development and nourishment. They are deposited in the tissues, and are seemingly stored there for emergencies. They usually exist in the blood in but small quantities, and are derived from the food; the glycogenic matter comes partly from the food and partly from the liver. They are of definite chemical composition. The fats, sugars, and starches are examples.

C. Organic Saline.

These principles are formed in the body by true chemical union. Pneumates and lactates are examples.

D. Inorganic.

These are principles not formed in the organism, and that remain unchanged while in the body. They are of definite chemical composition, and are crystallizable. The substances forming these are introduced from without the body, and are discharged from it in the same chemical form in which they entered the organism. In the body, however, they behave as organic principles, and are necessary for nutrition. The carbonates, phosphates, sulphates, water, and sodium-chloride are examples.

E. Excrementitious.

These are the waste principles and poisonous matter from the system, and result from the breaking down of tissues. Urea, carbonic acid, and cholesterin are examples. Cholesterin is a principle separated from the blood, in all probability, as shown by Flint and Müller, through the excrementitious function of the liver, and is discharged in the form of stercorin with the fæces. Urea is mainly discharged in the urine and sweat, the excrementitious fluids of the organism.

III.

Describe fully the Process of Mastication, and give the Mechanism of Deglutition.

A. Mastication.

Mastication is the process of dividing the food by the teeth, assisted by the tongue, cheeks, and lips, to prepare it for deglutition.

Mechanism. The movements in mastication are those of the lower jaw, the tongue, cheeks, and lips.

The lower jaw has three movements, a vertical, a lateral, and an antero-posterior. The vertical movement is an upward and downward motion. The upward motion, or closing the jaws, is caused by the contraction of the temporal, masseter and internal pterygoid muscles. The downward motion, or opening the jaws, is caused by the action of the digastric, the mylo-hyoid, the genio-hyoid, and the platysma myoides muscles. The lateral and the antero-posterior movements are caused, the former by the contraction of the muscles that elevate the lower jaw, acting unilaterally; the latter by the anterior and posterior portions of the pterygoid muscles contracting separately.

The tongue is in active and eccentric motion, the intrinsic fibers and extrinsic muscles both being engaged.

The muscles of the cheeks and lips act, also, in helping to keep the food between the teeth.

After the bolus is thoroughly masticated and insalivated, it is ready for deglutition.

B. Deglutition.

Deglutition may be divided into three stages. The first stage is voluntary, and extends from the time the food is pushed back, after being masticated, collected into a bolus, and insalivated, until it enters the isthmus faucium. The second stage extends from the time the food enters the isthmus faucium until the constrictors of the pharynx grasp it. The third stage extends from the time it enters the grasp of the constrictors until it reaches the œsophagus.

The First Stage. After the thoroughly masticated and insalivated bolus of food is forced back by the tongue, it rests on the posterior portion of that organ, which presses against it, and which is also applied to the roof of the mouth to prevent the return of the bolus. By this pressure of the tongue it enters the isthmus faucium.

The Second Stage. After the bolus has been pressed into the isthmus of the fauces, the tensor palati renders the soft palate tense; the levator palati draws it upward; at the same time the posterior pillars of the isthmus faucium contract, the chink between them being filled by the azygos uvulæ; the stylo-pharyngeus acts in concert now, and pulls the pharynx back, like the finger of a glove. This brings the roof in apposition to the superior constrictors, and excites just enough action in them to grasp it, thus closing the opening into the posterior nares. At this time the larynx is being raised by its five levators, the digastric, the stylo-hyoid, the mylo-hyoid, the genio-hyoid, and a few fibers of the hyo-glossus. The epiglottis is now covering the glottis, the floor of the pharynx is now an inclined plane, and the anterior pillars, the palato-glossus muscles, now contracting, force the bolus along this plane into the grasp of the superior constrictors.

The Third Stage. The constrictors, the superior, middle, and inferior, contract upon the bolus from above downward, and thus it is forced into the upper opening of the œsophagus, to be conveyed thence to the stomach by the peristaltic action of the œsophageal muscles.

IV.

Describe Saliva, Gastric Juice, Pancreatic Juice, and give the Mechanism of their Secretion and the Function of each.

A. Saliva.

Description. Saliva is a fluid which is secreted by glands situated around the cavity of the mouth. It is rather turbid, somewhat viscid, almost tasteless, and its reaction is alkaline. The turbidity is caused by the presence of epithelial cells, which are mixed with the salivary secretion. These cells come from the mucous glands of the mouth, and from the ducts of the salivary glands.

Mechanism of Secretion. The salivary glands are racemose glands, situated in the buccal cavities, in the fossæ of the lower jaw, and under the posterior portion of the tongue. They are lined with mucous membrane, and the investing epithelium differs in the ducts and in the glands. The glands proper, or terminations of the ducts, are lined with spheroidal or true glandular epithelium. The ducts are lined with columnar epithelium. In the body of the gland the proper secretion is separated from the blood. This is the function of the true gland cell wherever found. The epithelium lining the ducts secretes mucus. The glands and their ducts are:

The parotid, with Steno's duct.

The submaxillary, with Wharton's duct.

The sublingual, with the small ducts of Rivierè.

The secretion from the parotid is least viscid; that from the submaxillary next; and that from the sublingual most of all.

Function. The principal office of the saliva is, mechanically, to moisten the food and thereby assist deglutition; and, chemically, to thoroughly change the starches into dextrin, and then into sugar, either in the mouth or afterwards in the stomach.

The active principle is ptyalin.

B. Gastric Juice.

Description. Gastric juice is a fluid clear and amber-colored, with an acid reaction. It contains hydrochloric acid and mucus. It is secreted by the peptic glands, situated in the mucous coat of the stomach, by the glands that secrete hydrochloric acid, and by mucous follicles. The different glands secrete the different constituents, all being mixed together to form gastric juice.

Mechanism of Secretion. The peptic and the hydrochloric acid glands are very similar in their microscopic anatomy. They are racemose glands, and in the cellular or lobular portion are lined with spheroidal epithelium. The ducts are lined with columnar epithelium. The mucous follicles are lined throughout with columnar epithelium, and are mostly situated about the pyloric end of the stomach.

Function. The action of the gastric juice is upon the proteids. The product of its digestion is peptone. There is a small by-product which is called parapeptone. The gastric juice dissolves the envelope in which is held the fats, and it acts upon the fibrins, albumins, and gelatins by a disintegrating process. The substances swell up, and are reduced to a thin, pultaceous mass. Hydrochloric acid is necessary to its proper function, and to the presence

of this principle is due the fact that gastric juice is normally acid in its reaction.

The active principle is pepsin.

C. Pancreatic Juice.

Description. Pancreatic juice is *the* digestive factor. It is similar to the salivary secretion in that its reaction is alkaline. It is viscid and translucent.

Mechanism of Secretion. The pancreatic juice is secreted by the pancreas. This is a long, narrow organ, situated below and behind the stomach. It extends from the right to the left hypochondriac region, completely across the epigastric. It is composed of lobes. The secreting sacs, or terminations of the divisions of the ducts, are lined at the base with demilune cells; on these are the true gland cells. The ducts are lined with columnar epithelium. The small ducts join together, and form two: one that is large and opens into the duodenum, in company with the bile duct; and one that is smaller, and opens a little above this, which Bernard alone has found.

Function. The pancreatic fluid acts on all the food that has not been digested by either the saliva or gastric juice. It emulsifies the fats.

The active principle is trypsin.

V.

In the Digestive Process, describe the Sucessive Stages by which the Food finally enters the Blood.

The food, after being properly digested, enters the blood by some process of absorption.

In the stomach the water and more fluid portions of the food are taken up by the capillaries, and enter directly into the venous circulation.

In the intestines are found the villi. These contain lacteals and capillary blood-vessels. The chief office of the lacteals is to absorb the fats; but during active digestion they are found to contain other substances. The lacteals convey their contents to the receptaculum chyli, and thence the thoracic duct carries it to the venous blood. The capillary blood-vessels in the villi take up the fluid, which, after absorption, is known as chyle. These capillaries pour this into the portal vein.

Absorption takes place from the mouth to the anus, the *degree* being different in different parts of the alimentary canal, the *process* always the same.

VI.

Give the Relation of the Nervous System to the Glycogenic Function of the Liver.

The relation of the nervous system to the glycogenic function of the liver is not clearly known. It is intimate, however. The controlling influence seems to be centered in the floor of the fourth ventricle; for if this is punctured, artificial diabetes will result. The impulse is sent to the liver by other nerves than the pneumogastric; for even if these are severed the glycogenic function, though suspended for a time, again becomes normal. The connection of the sympathetic system is not known.

VII.

Give the Physiological Anatomy of the Kidney, and the Mechanism of the Secretion and Excretion of Urine.

A. Physiological Anatomy.

The kidneys are situated in the lumbar region, and are oblong, symmetrical bodies. They are inclosed in a coat of adipose tissue, inside of which is their proper covering, the fibrous capsule.

The fibrous capsule surrounds the kidney, and is continuous with the fibrous covering of the pelvis and ureters. It sends trabeculæ into the cortical substance of the kidney. The kidney is composed of a cortical and a medullary substance.

The cortical substance is granular. It occupies the exterior portion of the organ to the general depth of one-sixth of an inch, and sends down prolongations into the medullary substance. The cortical substance contains granular matter, Malpighian bodies, capillary plexuses of blood-vessels, convoluted uriniferous tubules, and the columns of Bertin.

The medullary substance is found interior to this cortical layer, and is sometimes called the pyramidal substance, being composed of the pyramids of Malpighi.

Blood Supply. The renal artery enters at the hilum, and, after dividing, passes forward toward the cortical substance. The divided arteries continue to follow the same

direction until they reach the bases of the pyramids, on which they form an anastamosing plexus. From this plexus branches are given off; those on the convex side extend out into the cortical substance, and each ramification becomes the afferent vessel of a Malpighian body, and after entering the body breaks up into minute branches, which form a dense convolution known as the glomerulus. The branches toward the concavity of the base of the pyramid pass backward toward the hilum, and terminate in the capillaries of the pyramidal substance. These are called the arteriolæ rectæ.

The veins originate in three ways,—from stellated radicles near the external surface of the cortical substance; from the capillary plexus about the convoluted tubes; and from the capillary plexus, in which the arteriolæ rectæ terminate.

Malpighian Body. This is composed of an afferent and and an efferent vessel, forming a capillary plexus, without anastomosis, within the terminal expansion of a uriniferous tubule, the capsule of Müller.

Tubuli Uriniferi. These are tubes beginning in the capsule of Müller, and extending to the calices. They are convoluted in the cortical substance; on reaching the border of the medullary substance they become less so, and much narrower, and dip down into the pyramids, returning again to the cortical substance. Throughout this part of their course they are called the looped tubes of Henle. They again enter the pyramids of Malpighi, and their course is now more directly toward the pelvis. Several of them join together, forming larger tubes. In this part of their course they are called tubuli recti uriniferi, or the strait tubes of Bellini.

Pyramids of Malpighi. These are the large pyramids of the medullary substance, and are composed of lesser pyramids, called pyramids of Ferrein.

Pyramids of Ferrein. These are collections of uriniferous strait tubes, about a hundred in each.

Calices. These are little openings into which the apices of the pyramids are received.

Infundibula. These are the short, funnel-shaped tubes into which the calices open.

Hilus. This is the gateway of the kidney.

Pelvis. This is the expansion of the ureter, and into it the infundibula open.

Epithelium. The cells lining the strait tubes are polygonal in shape. It is supposed that those in the convoluted portion of the tubules are true gland cells, and that the capsule of Müller is lined with pavement epithelium.

B. Mechanism of Secretion.

The secretion of urine takes place in the Malpighian body and convoluted uriniferous tubes. The watery elements are principally separated in the glomerulus; the other constituents in the tubes, from the blood in the capillaries that surround them. The separation in the Malpighian body is effected mainly by pressure; that in the tubes, by the action of the true gland cell. The efferent vessel, after leaving the Malpighian body, is about one-half the size of the afferent. It still contains matter that is excrementitious; so its course is directed toward the convoluted tubes, and it forms a plexus about them to allow this waste matter to be extracted from the blood. When the renal vein is finally formed, it contains the purest blood in the body.

VIII.

Give the Mechanism of Respiration, and the Means by which Oxygen is conveyed to the Tissues.

Respiration is of three kinds—pulmonary, cutaneous, and muscular.

A. Mechanism of Pulmonary Respiration.

Inspiration. The act of inspiration is performed by the muscles of inspiration, working in concert with those muscles that open the rima glottidis. In inspiration the rima glottidis is opened, and the walls of the thorax are extended. This extension of the walls causes a tendency to a vacuum, and the air rushes in to fill it. The muscles of inspiration are the diaphragm, the scaleni, the external intercostals, and the levators of the ribs, with accessory muscles, which are the serratus posticus superior, the sterno-cleido-mastoideus, the pectoralis major and minor, the serratus magnus, and the levator anguli scapulæ.

Expiration. The act of expiration is performed by the muscles of expiration and by the contraction of the tracheales muscles and of the elastic fibers found in the walls of the air-cells. The expiratory act is more passive than the inspiratory, and occupies about one-fourth the time of respiration. The muscles of expiration are the triangularis sterni, the sacro-lumbalis, the external and internal abdominal oblique, the transversalis, the infra-costales, and the internal intercostals.

B. Means by which Oxygen is conveyed to the Tissues.

Oxygen rushes in with the air when the lungs are filled. By the law of diffusion of gases, it rapidly passes through the air already in the lungs, and is brought in apposition with the membrane which lies between it, and the blood charged with carbonic acid gas.

The interposition of the membrane favors diffusion. The oxygen passes in, and the carbon di-oxide out, still by the law of diffusion. The oxygen now enters into chemical union with the hemaglobin of the red corpuscle, forming oxy-hemaglobin, and then this servant of the cells, the red corpuscle, carries the oxygen to the capillaries; here, the tissues having a greater affinity for the oxygen than has the hemaglobin, it enters their structure, and leaves the corpuscle, the carbon di-oxide being taken back to the lungs in exchange for the oxygen left with the tissues.

IX.

Give the Mechanism of a Continuous Flow of Blood in the Veins, and the Causes of a Systemic Venous Pulse.

The three factors of a continuous flow of blood in the veins are the *vis a tergo*, or action of the heart, the overdistension of the arteries, and the peripheral resistance of the capillaries. When these three factors bear a normal relation to each other, the stream of blood flows continuously in the veins. When any one of them is disturbed without a proper compensation in another, a venous pulse is the result.

The First Factor. If the defect is either in the valves of the heart or in the stroke, there will not be sufficient force to *overdistend the arteries.* The impulse will be transmitted on through the capillaries into the veins, for the arteries are then, practically, inelastic tubes, and exert no modifying influence.

The Second Factor. If the weakness is in the coats of the artery, even though there be a sufficient heart-impulse, the elasticity of the arteries not being great enough to modulate it, it will *still* propagate itself through the capillaries into the veins.

The Third Factor. If the peripheral resistance of the capillaries is lessened sufficiently, as when their walls are dilated from any nervous cause, the arteries will not be over-distended, and the impulse will continue on through the whole circulation.

X.

Describe fully a Nerve, and give its Physiological Properties.

A. Description.

A nerve is a conductor of impulses and impressions.

It is composed of one or more bundles of nerve fibers, held together by an investing sheath.

Nerve fibers are of three kinds,—the medullated, the non-medullated, and the gelatinous.

The Medullated Fibers are those which contain, in addition to the axis-cylinder, a surrounding envelope of medullary substance, called the white substance of Schwann. This is in turn surrounded by the sheath of Schwann, a homogeneous membrane containing oval nuclei longitudinally arranged. In this sheath are contractions, the striæ of Frommann, but they do not extend to the axis-cylinder.

The Non-medullated Fibers are those which are of the same structure as the foregoing, except they do not contain medullated substance. They are found at the origin and at the peripheral extremities of the nerves generally.

The Gelatinous Fibers, or fibers of Remak, are gray in color, of a flattened shape, and contain oval nuclei. They are not abundantly found. More are present in the sympathetic than in the cerebro-spinal system. They are most numerous in fœtal life, and are present in regenerating

nerve tissue. They have been denied a classification as nerve fiber by some authors, and have been called simply connective tissue. Others have not regarded them as distinctive nerve fibers, but have considered them to be undeveloped or rudimentary fibers of the medullated or non-medullated variety.

The axis-cylinder seems to be the part of the nerve essential to its proper function, as it is constant from the origin to the termination. It is marked by longitudinal striations, which are thought, by some writers, to indicate a fibrillated structure.

The nerve fibers are bound together by the perinèvre into primitive bundles or funiculi. These bundles are again gathered together, and held by the perineurium. This constitutes a nerve, although the smaller nerves contain sometimes but one funiculus. Besides the nerve fibers and sheaths, each nerve contains accessory anatomical elements; as, blood-vessels, probably lymphatics, connective tissue, and nervi nervorum.

Nerve fibers neither branch nor divide, but continue uninterruptedly from center to periphery. A fiber from one nerve will cross to another, thus assisting in co-ordination.

The nerves of the cerebro-spinal system originate in the brain from different parts of its structure; in the spinal column by the anterior and posterior roots, the motor, and co-ordinating and sensory, from the spinal cord. The sympathetic system is a chain of nerves and ganglia connected with the cerebro-spinal system, and dependent upon it.

Nerves terminate, *generally*, by gradually becoming less in diameter, until they are lost to the microscopic eye. They terminate *specially* in the terminal plates of the muscles, the taste bulbs, the tactile corpuscles, and the corpuscles of Krause.

B. Physiological Properties.

The axis-cylinder *conducts*, the other parts are accessory. The nerves are carriers, both from the center to the periphery and in the opposite direction. The efferent fibers bear motor impulses from the brain. The afferent fibers convey sensory impressions to the brain. There is no known difference between the afferent and efferent nerves in anatomical structure.

Nerves possess the property of irritability to a marked degree. They can be stimulated by electricity, which resembles nerve force. They are capable of being regenerated. They are conductors of nerve force or vitality. That they are the connecting link between the brain and the outside world is known; but how the brain and the governing mind are united, neither the physiologist nor the microscopist has revealed.